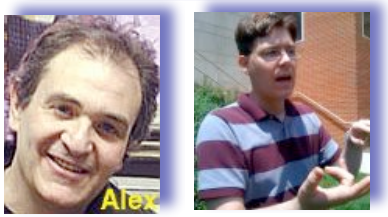
Instant Analyses in **AFNI** and **SUMA**: Clusters and Correlations

Data for this presentation:
AFNI_data5/ directory

All data herein from Alex Martin, *et al*. [NIMH IRP]

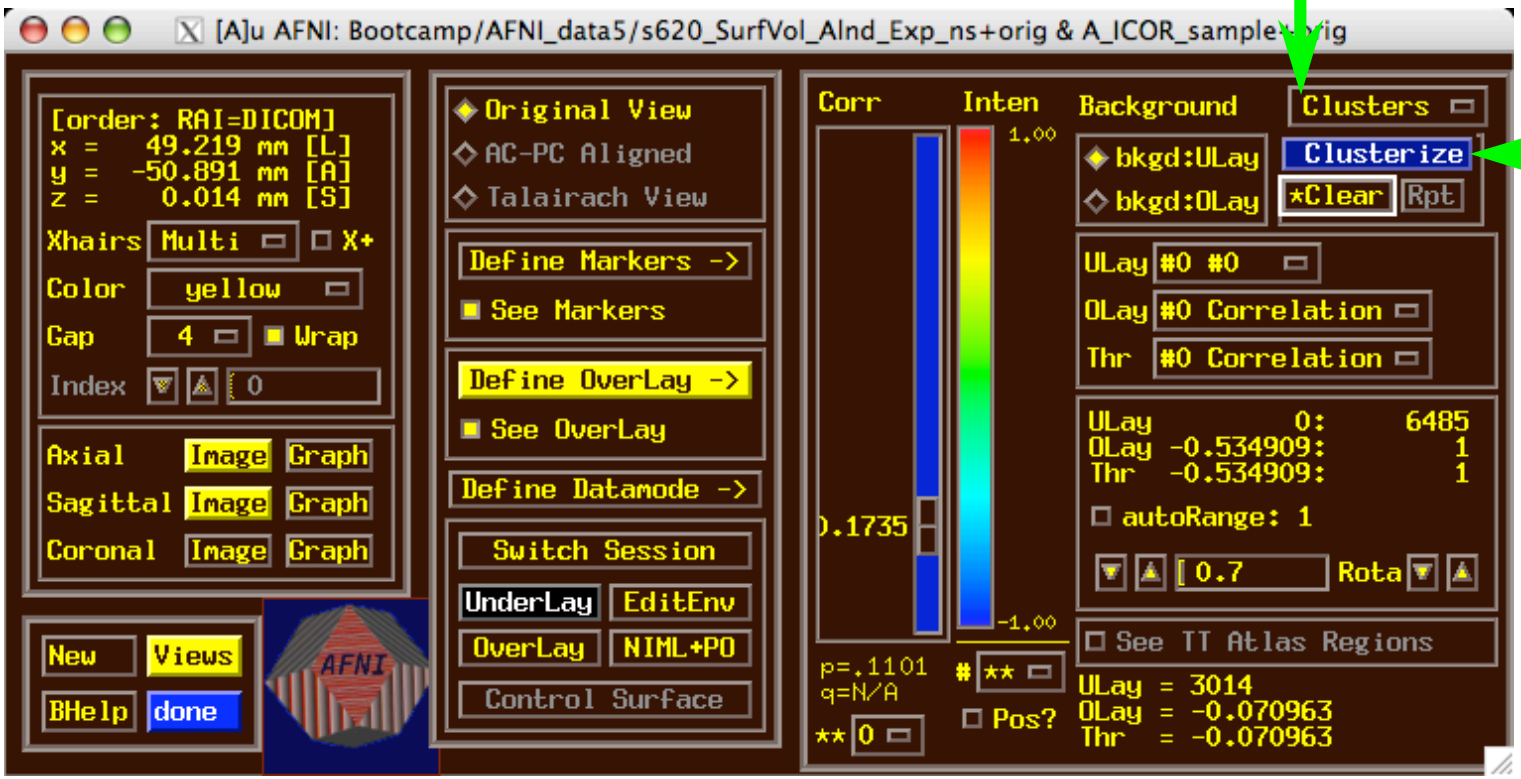


AFNI "Insta" Functions

- 3 new capabilities added to the interactive AFNI
- Each one: compute new dataset volumes **insta**ntly to replace the Overlay volume for image viewing
- **Clusters** = interactive clustering
  - ★ remove clusters below a user-chosen size
  - ★ display a table of clusters
- **InstaCorr** = interactive exploration of inter-voxel time series correlation
  - ★ choose a seed voxel and see correlation map
  - ★ SUMA version also exists
- **InstaCalc** = interactive version of **3dcalc**
  - ★ e.g., display ratio of 2 datasets

AFNI Clusters: Setup

- Open **Define Overlay**, choose **Clusters** from menu in top right corner



- Then press **Clusterize** to get the clusters control menu

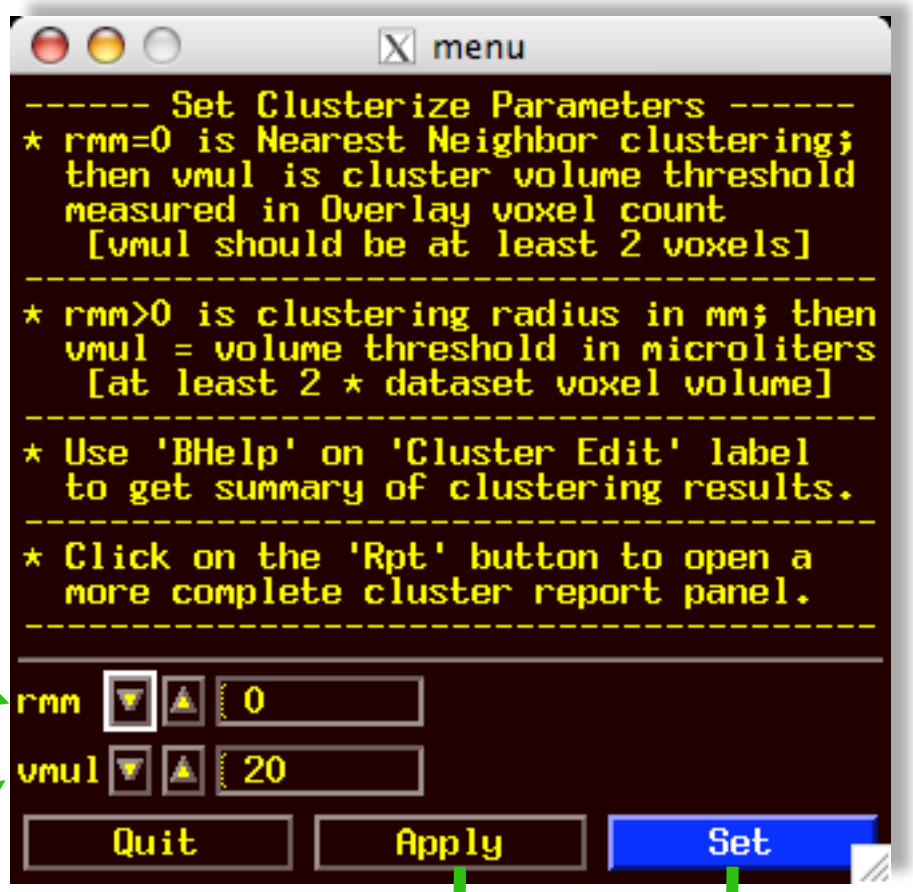
Clusters Control Menu

Operates on user's chosen Overlay dataset at the user's threshold;
Next slide example:
AFNI_ICOR_sample

Default: NN clustering

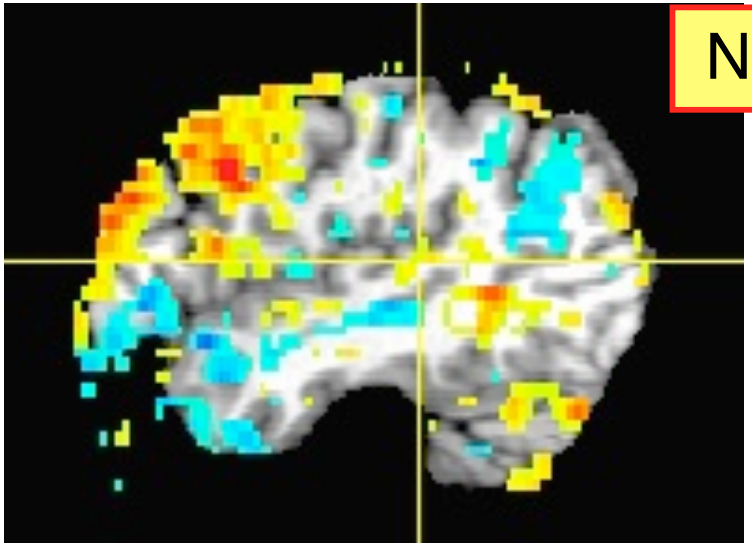
Default: 20 voxel minimum cluster size

Clustering is done in 3D

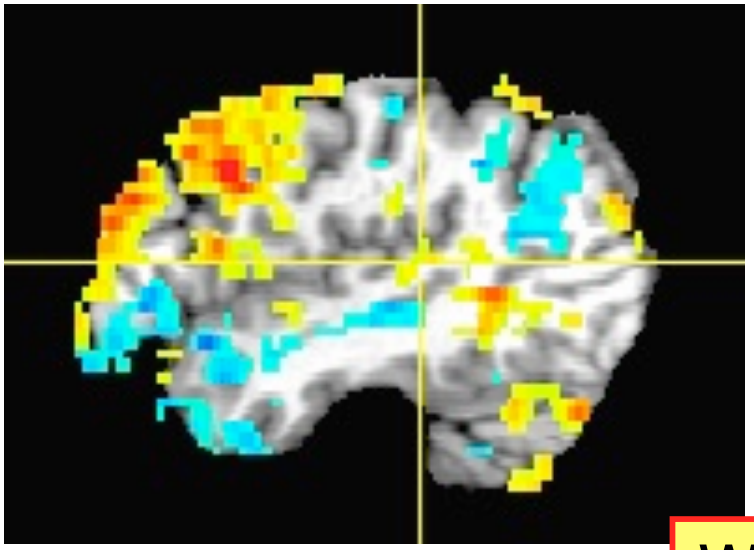


Press one of these buttons to create clusterized volume for display as new Overlay

Clusters Results



No clustering

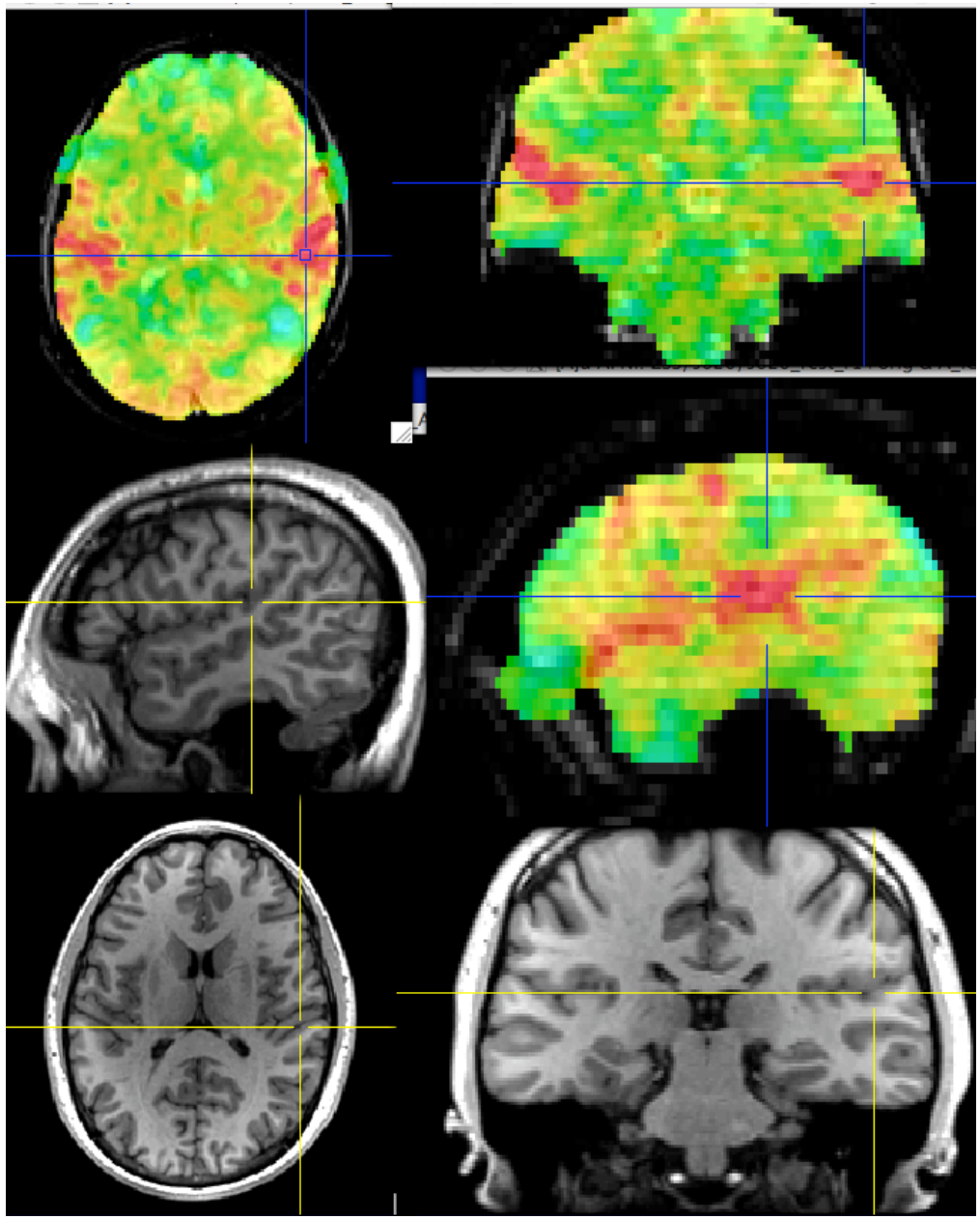


With clustering

Cluster report window

Jump: crosshairs move
Flash: colors on & off

AFNI! InstaCorr



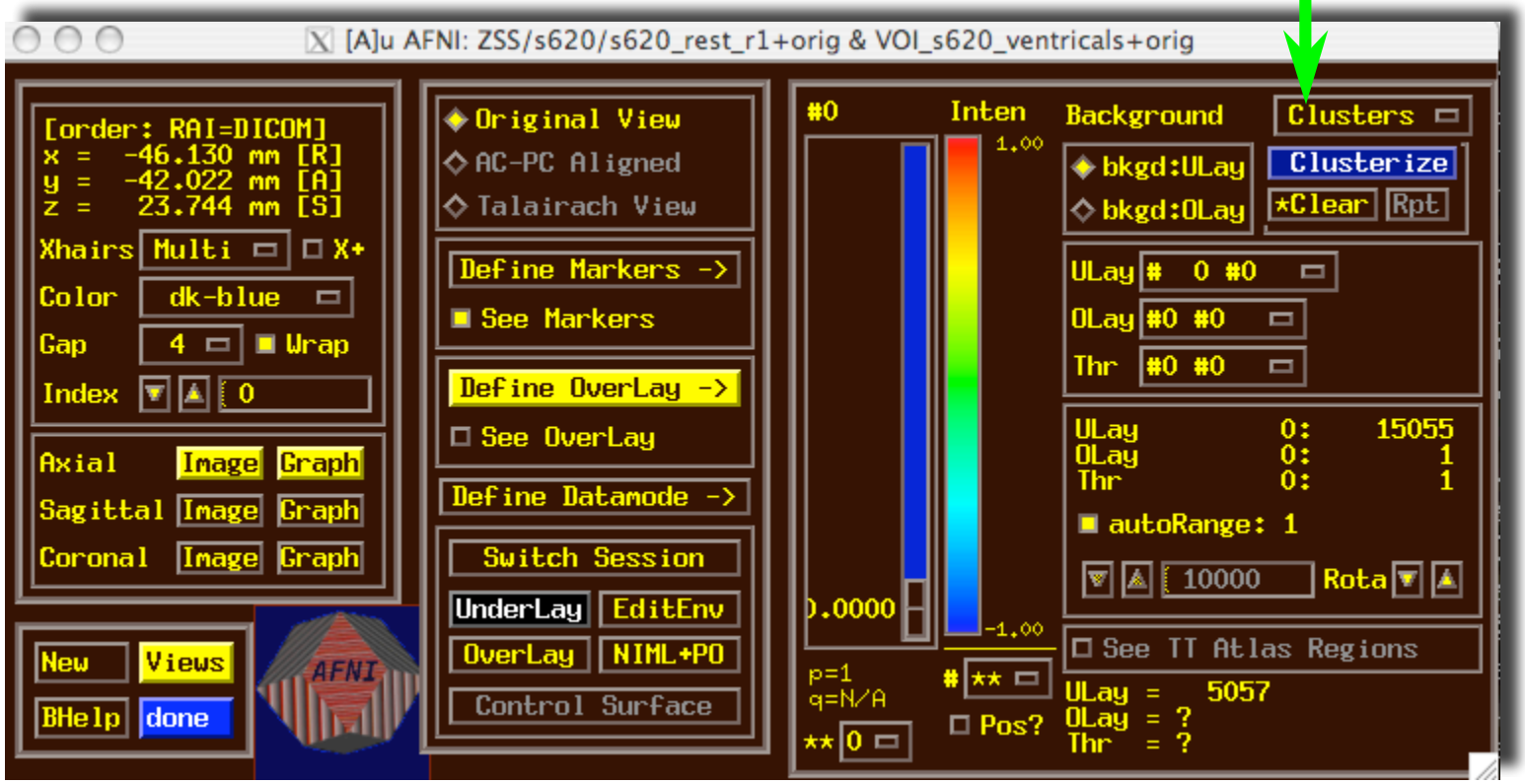
- On-the-fly **insta**ntaneous **corr**elation map of resting state data with interactively selected seed voxel
- **Setup phase**: prepares data for correlations (several-to-10+ seconds)
- **Correlation phase**: you select seed voxel, correlation map appears by ***magic***

InstaCorr: Outline of 2 Phases

- **Setup phase**:
  - ★ Masking: user-selected *or* Automask
  - ★ Bandpass and other filtering of voxel time series
  - ★ Blurring inside mask = the slowest part
- **Correlation phase**:
  - ★ Correlate selected seed voxel time series with all other prepared voxel time series
  - ★ Make new dataset, if needed, to store results
  - ★ Save seed time series for graphing
  - ★ Redisplay color overlay
  - ★ Optional: compute FDR curve for correlations
    - o Calculation is slow, so FDR is not turned on by default

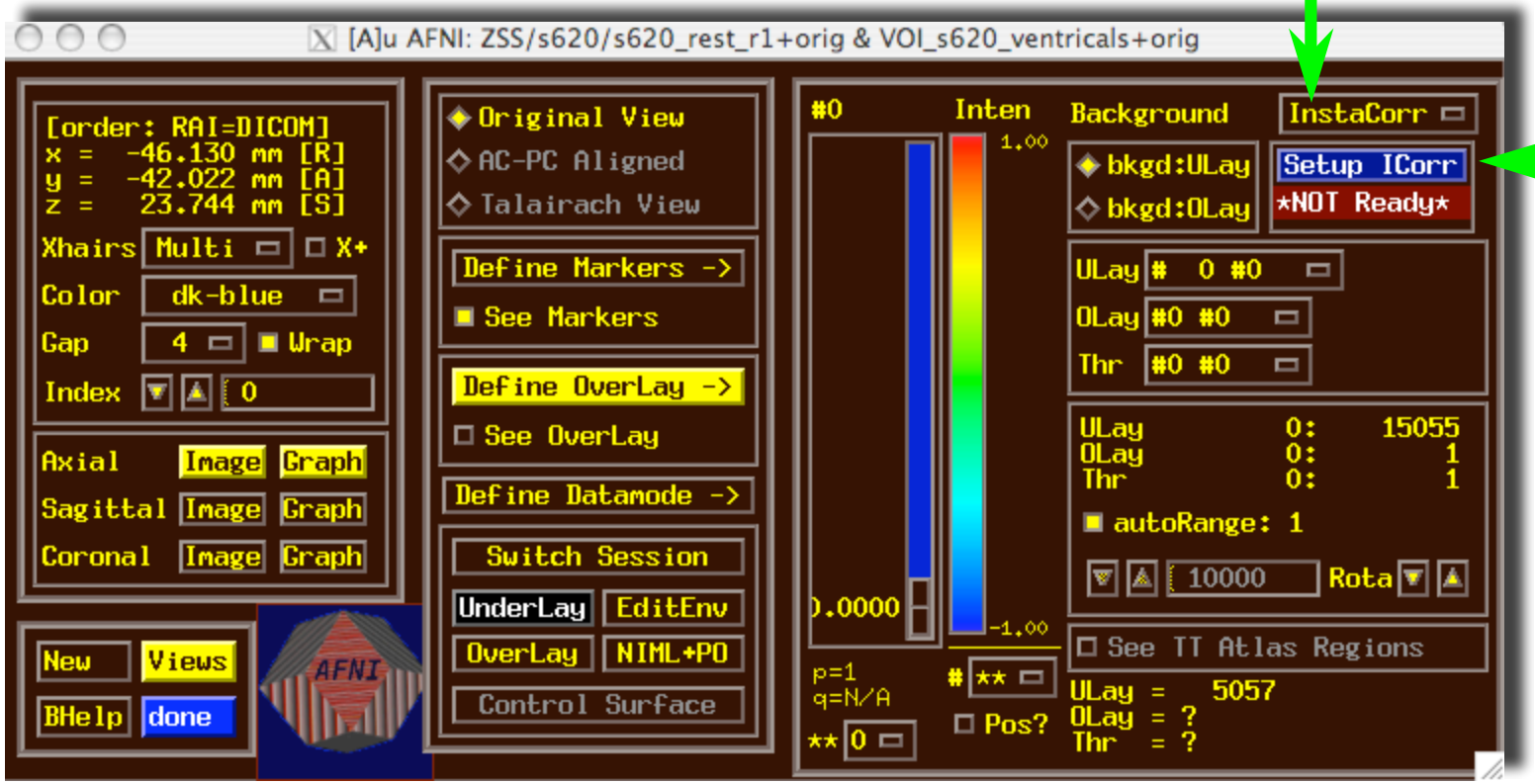
InstaCorr: Setup

- Open **Define Overlay**, choose **InstaCorr** from menu in top right corner



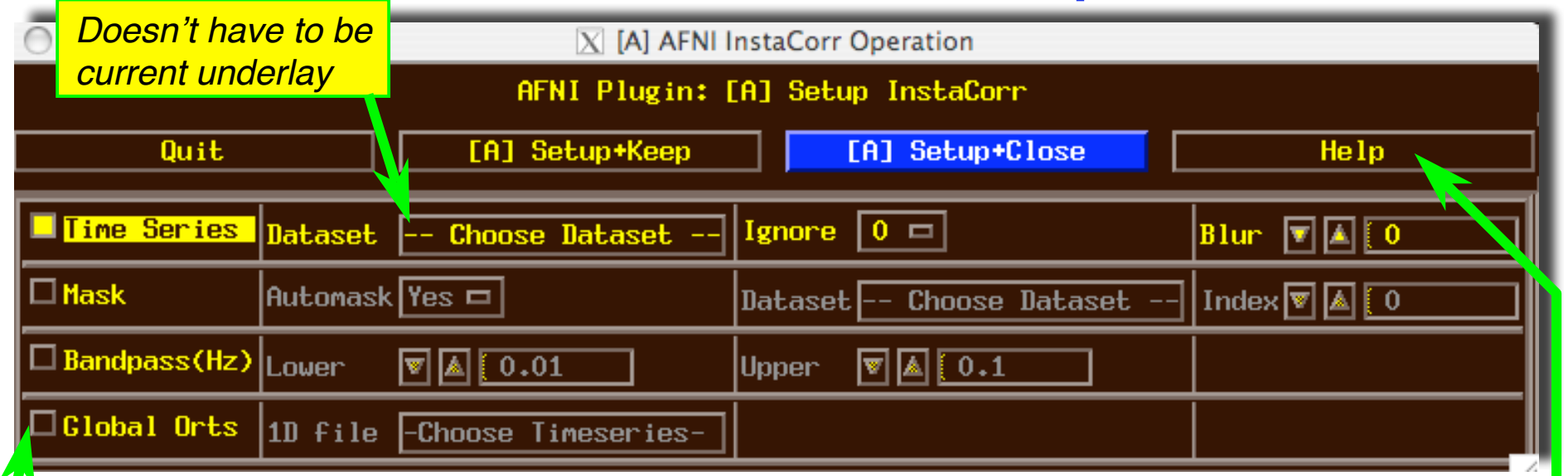
InstaCorr: Setup

- Open **Define Overlay**, choose **InstaCorr** from menu in top right corner



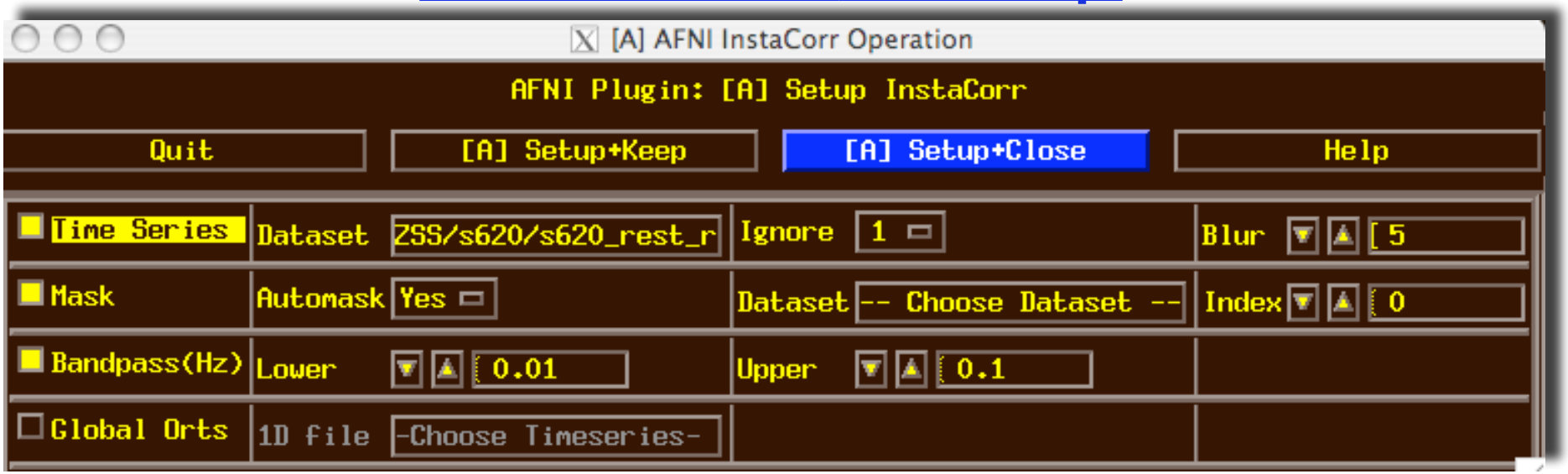
- Then press **Setup ICorr** button to get control panel

InstaCorr: Setup



- Mostly self-explanatory (I hope) — *cf.* **Help**
- **Global Orts** = extra time series to be projected out of dataset before correlation
  - ★ All columns in selected 1D file
  - ★ *e.g.*, movement parameters
  - ★ The first **Ignore** rows (time points) will be skipped
- When ready, press one of the **Setup** buttons

InstaCorr: Setup



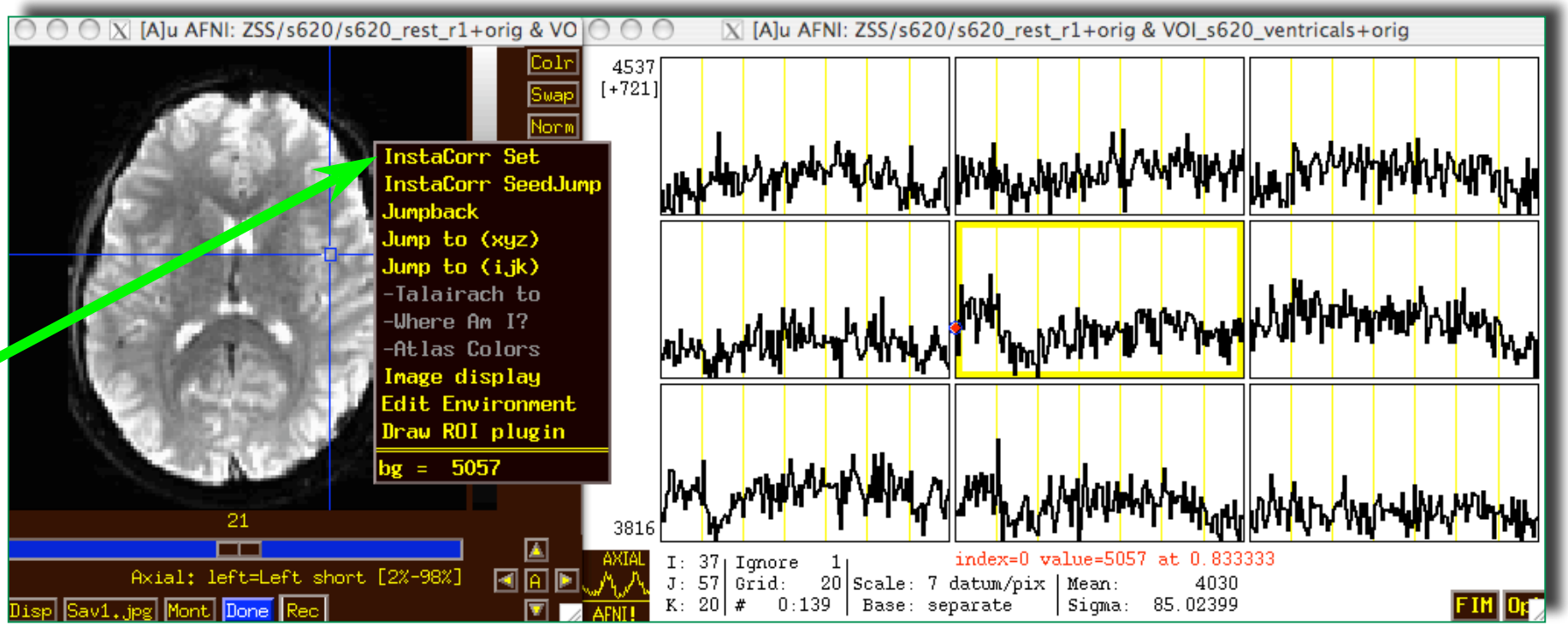
- Text output to shell window details the setup procedures:

```
++ InstaCorr preparations:
 + Automask from
  '/Users/rwcox/data/Resting/ZSS/s620/s620_rest_r1+orig.BRIK' has
  197234 voxels
 + Extracting dataset time series
 + Filtering 197234 dataset time series
 + bandpass: ntime=139 nFFT=160 dt=3.5 dFreq=0.00178571
  Nyquist=0.142857 passband indexes=6..56
 + Spatially blurring 139 dataset volumes
 + Normalizing dataset time series
++ InstaCorr setup: 197234 voxels ready for work: 15.43 sec
```

Dataset being analyzed

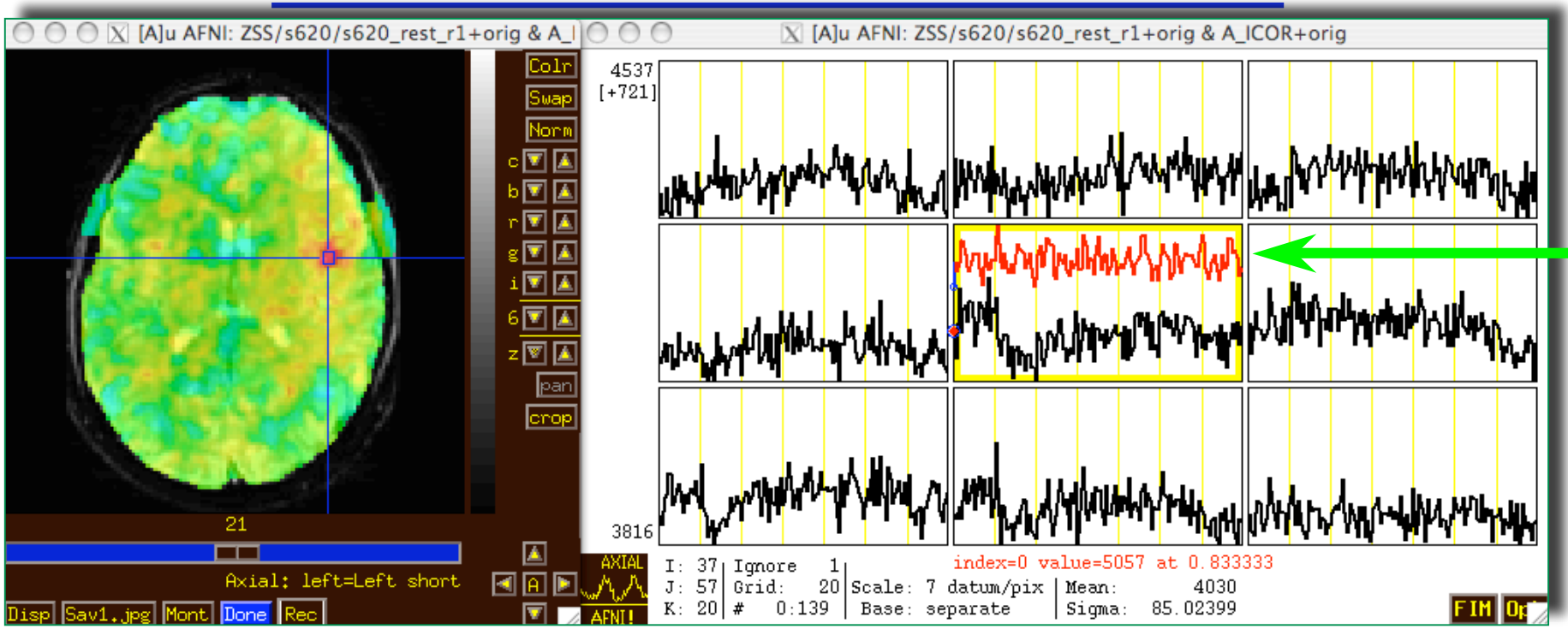
Most of the CPU time:
Uses `BlurInMask`

InstaCorr: The Fun Part



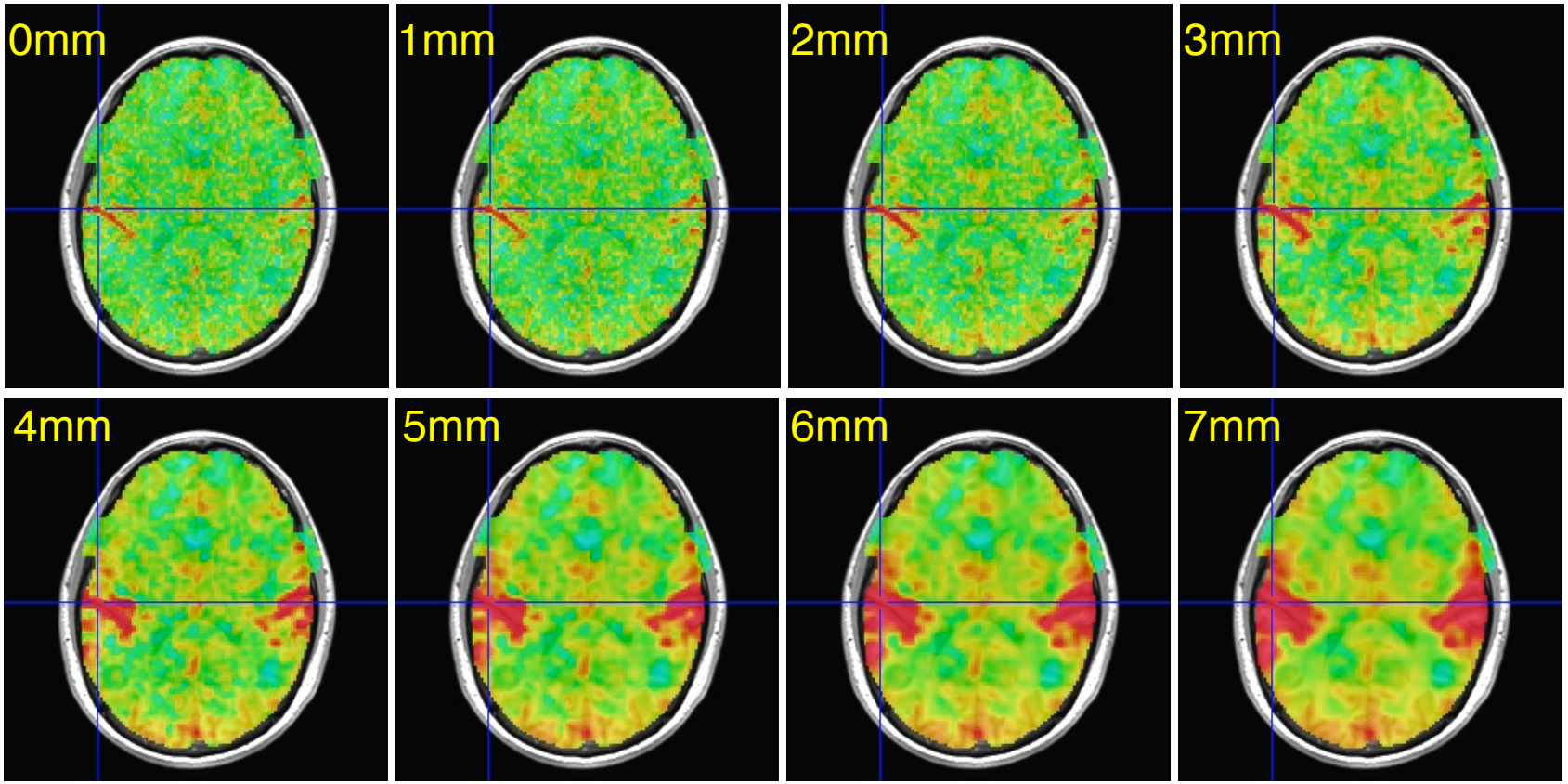
- In image viewer, set crosshairs to desired seed voxel
- **Right-click** popup menu → `InstaCorr Set`
  - ★ Creates new dataset **`A_ICOR`** for Overlay
- ***Shortcut***: **Shift+Ctrl+Left-click** sets new crosshair location, then does `InstaCorr Set`
- `InstaCorr SeedJump` jumps focus to current seed

InstaCorr: The Fun Part



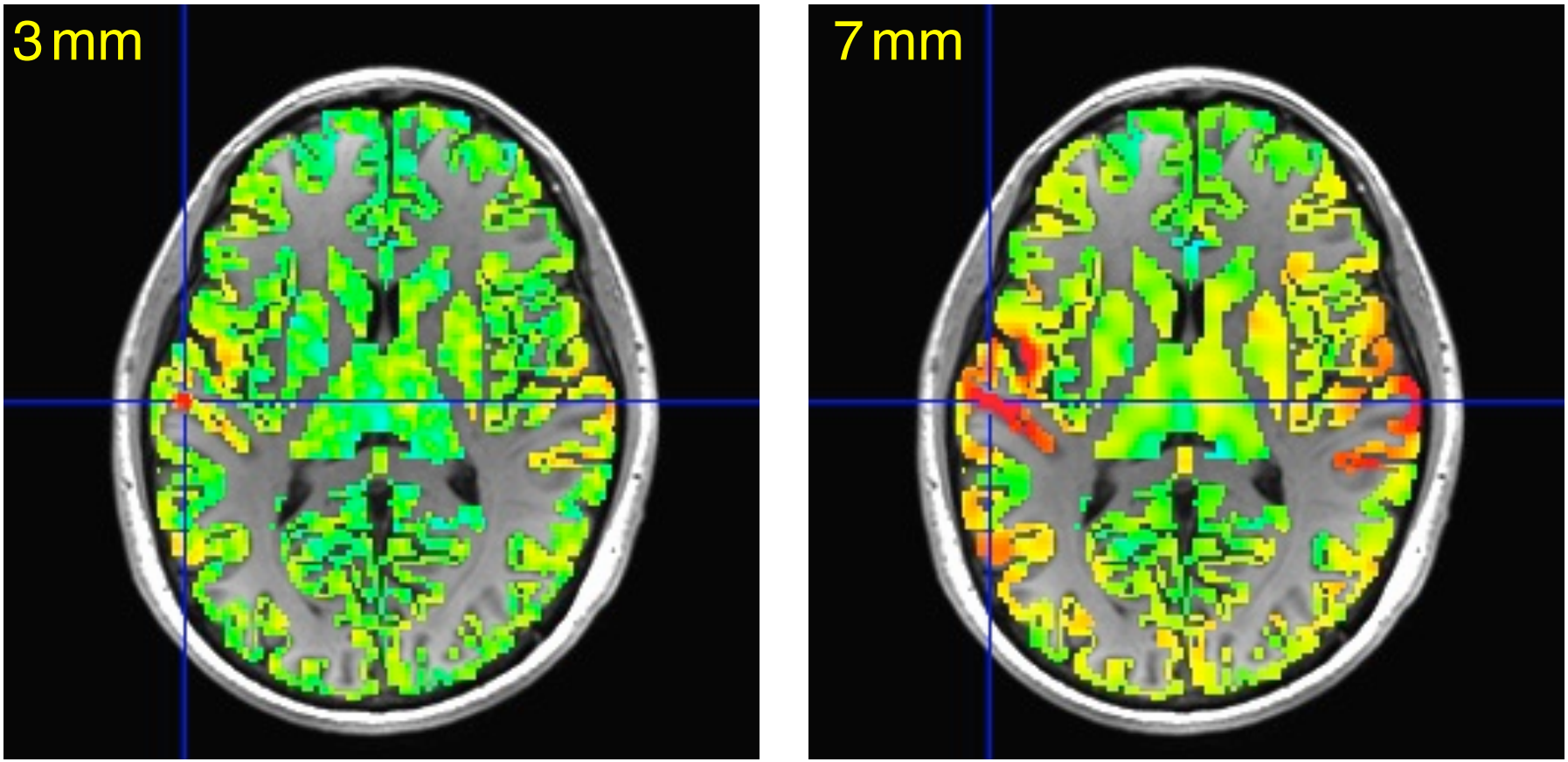
- In graph window:
  - ★ Set **Ignore** with **FIM→Ignore** menu (or **I** key)
  - ★ Set seed overlay with **FIM→Pick Ideal** menu
- When you change seed voxel, saved overlay time series will change (but you have to refresh graph to see it)

InstaCorr: Effects of Blurring



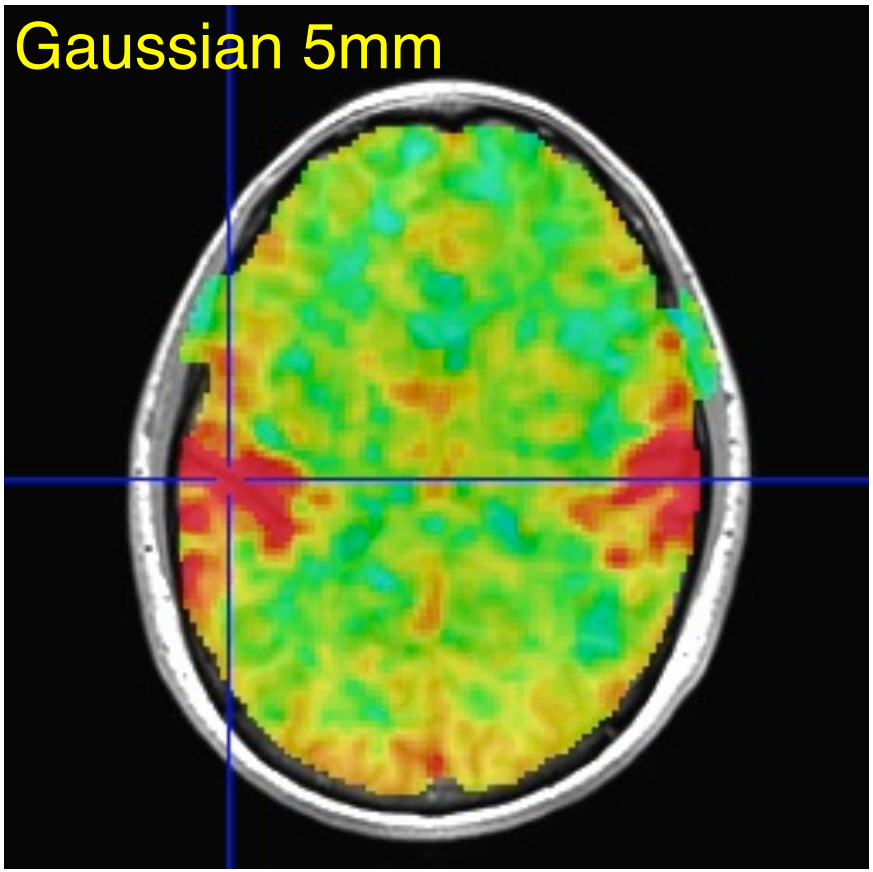
- Is this a pure vascular/cardiac effect being progressively smeared? Or real neural correlations seen via BOLD? Or some of both? *Venograms*?
  - ★ Dataset was RETROICOR-ized; mask is whole brain

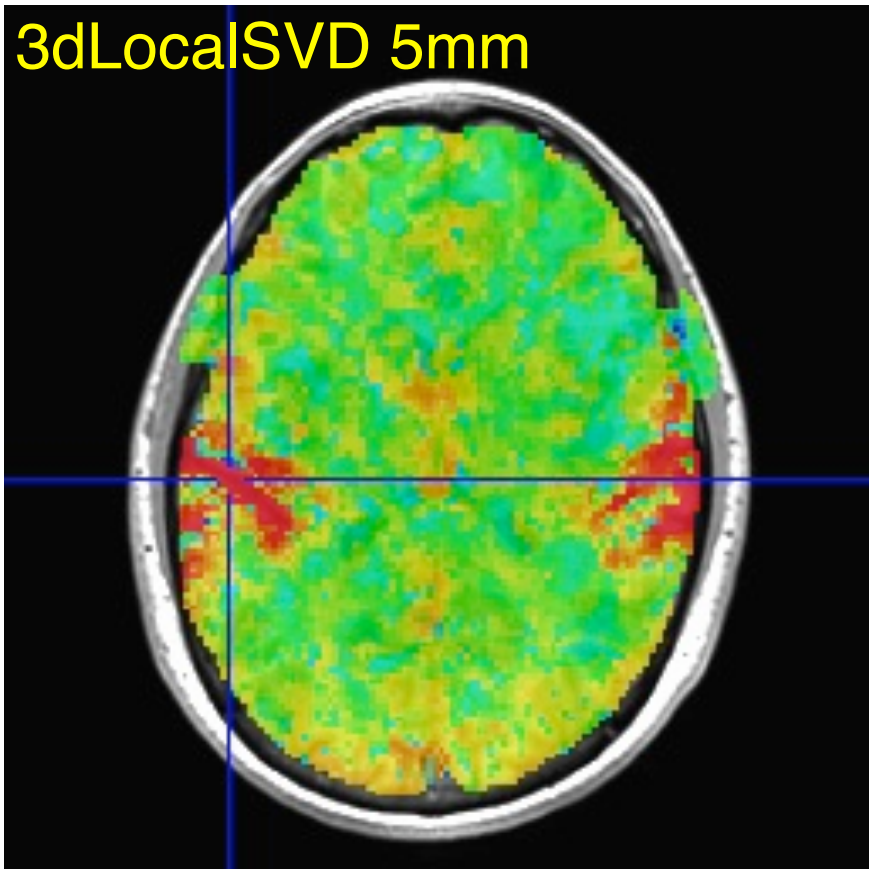
InstaCorr: Effects of Blurring



- Similar calculations, but with FreeSurfer-generated gray matter mask instead of Automask from EPI data
  - ★ Blurring is done only inside the mask (`3dBlurInMask`)
    - o Using a discrete PDE-based iterative approach

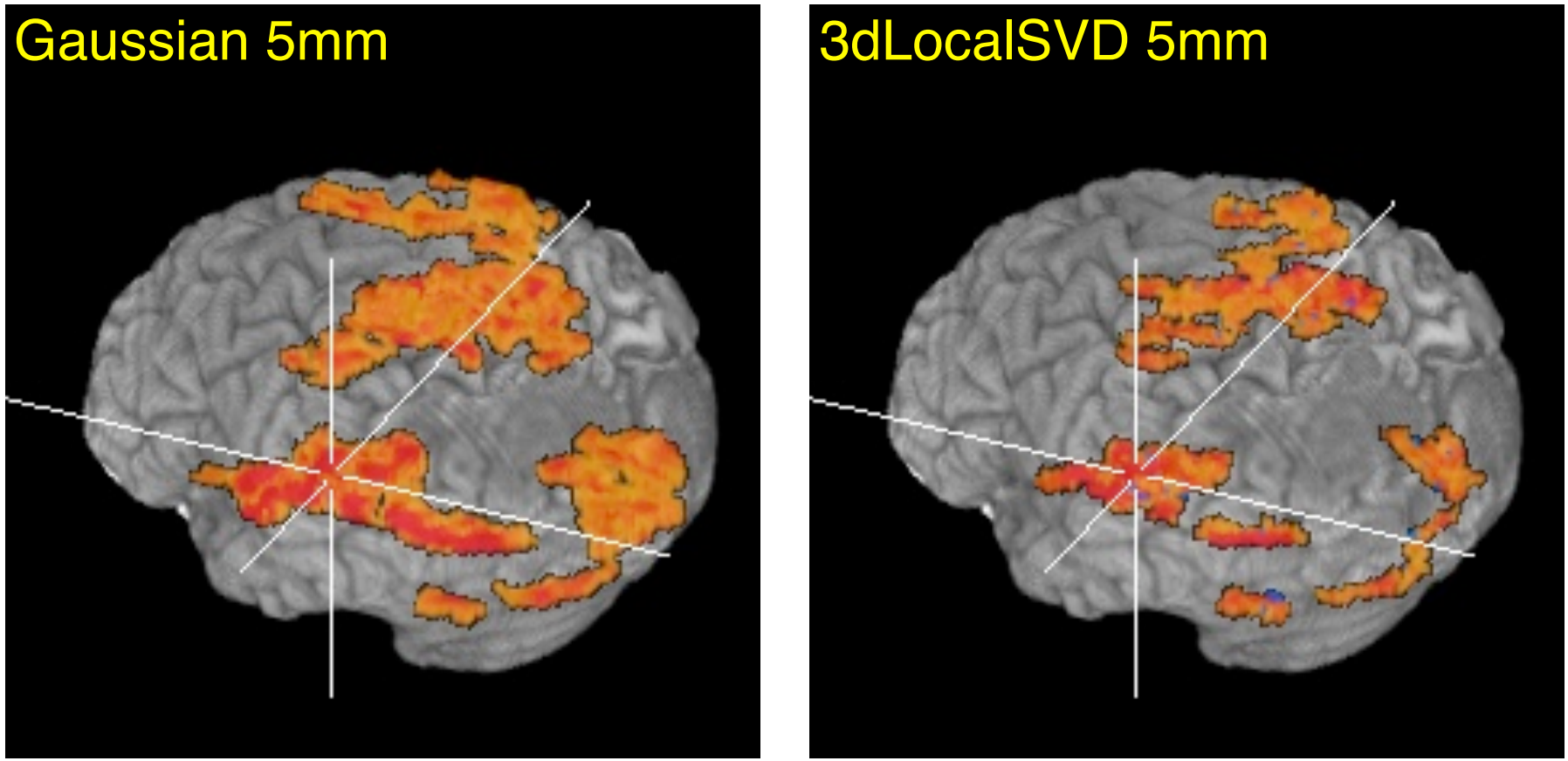
InstaCorr: SVD-based "Blurring"





- Similar calculations, with Automask from EPI data, using `3dLocalSVD` over 5 mm radius sphere (67 voxels)
  - ★ Project each vector onto 2-dim principal subspace
  - ★ Far too slow to calculate interactively (at this time)

InstaCorr: SVD-based "Blurring"



- Volume rendering of InstaCorr maps (threshold at r=0.5)
  - ★ Renderer updates automatically if DynaDraw is on
- SVD smoothing has cleaner spatial structure?
  - ★ Or has it lost some information? *I don't know.*

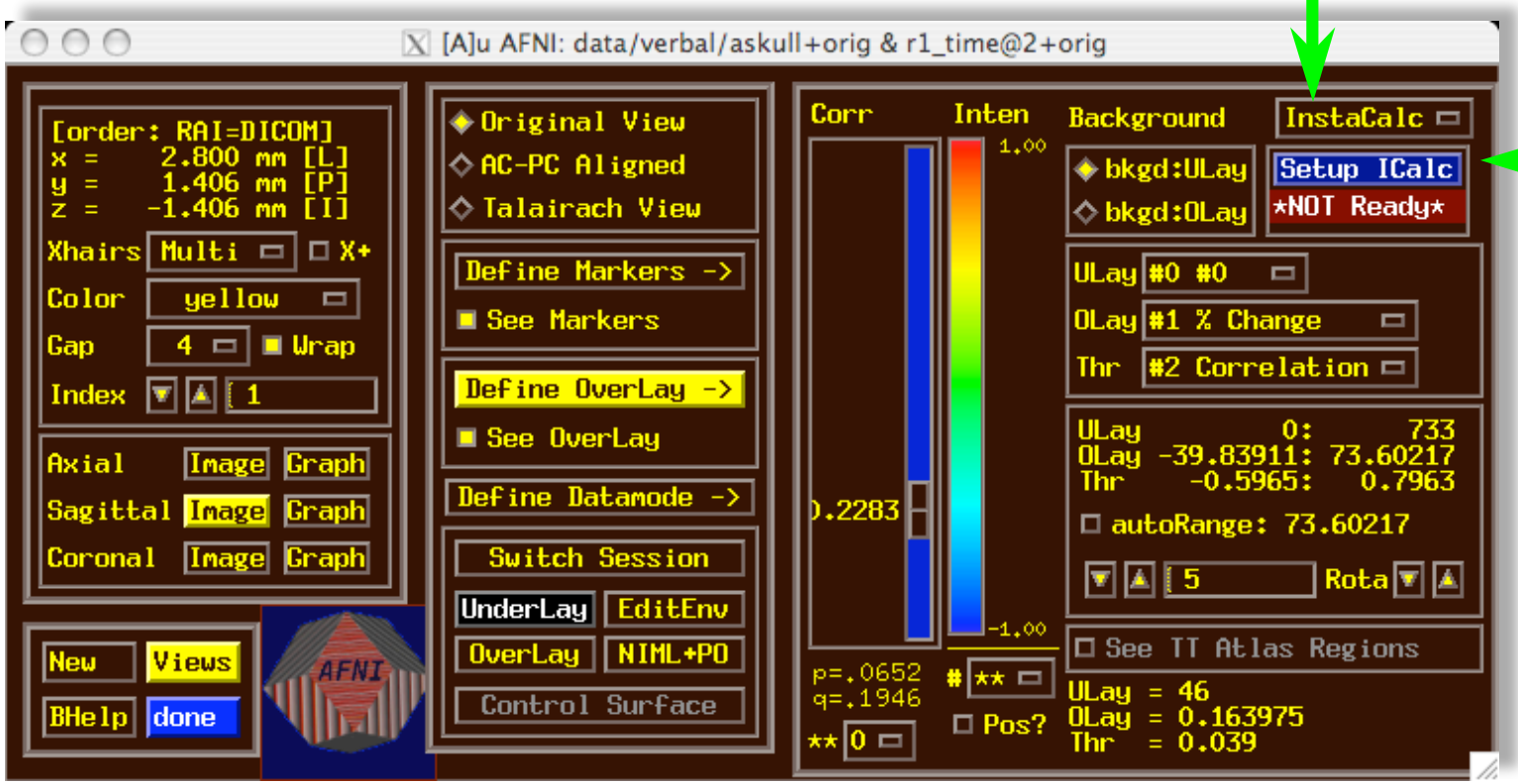
InstaCorr: Options and Plans

- Underlay doesn't have to be EPI data; could be anat
  - ★ Can use InstaCorr in multiple AFNI controllers
- FDR: `setenv AFNI_INSTACORR_FDR YES`
  - ★ Will slow things down by a significant factor
- Saving `A_ICOR` dataset: overwrites previous copies

- Future Possibilities:
  - ★ Select ROI-based Orts to be detrended?
    - o Based on ROIs from FreeSurfer or atlases?
  - ★ Or multiple seeds (partial + multiple correlations)?
  - ★ Interactive local SVD "smoothing"? (needs speedup)
  - ★ Group analysis InstaCorr (in standardized space)
    - o Not quite "Insta" any more; ≈0.1×#Subjects sec per seed
    - o External script to do subject setups?
  - ★ Use time series subsets? (*e.g.*, for block design data)

InstaCalc: Dataset Calculator

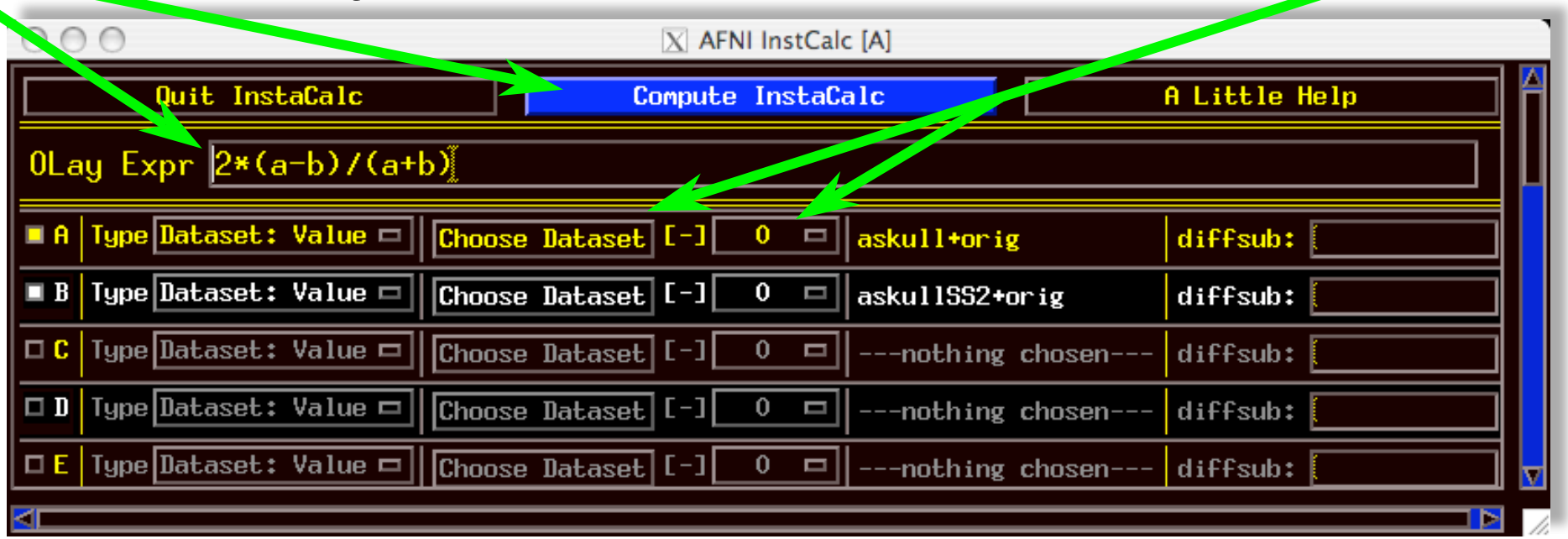
- Open **Define Overlay**, choose **InstaCalc** from menu in top right corner



- Then press **Setup ICalc** button to get control panel

InstaCalc: Setup

- Select datasets with `Choose Dataset` buttons
  - ★ and sub-bricks with the `[-]` controls
- Enter symbolic expression
- Press `Compute InstaCalc`
- Creates new 1-brick dataset **`A_ICALC`** for Overlay
  - ★ voxel-by-voxel calculations

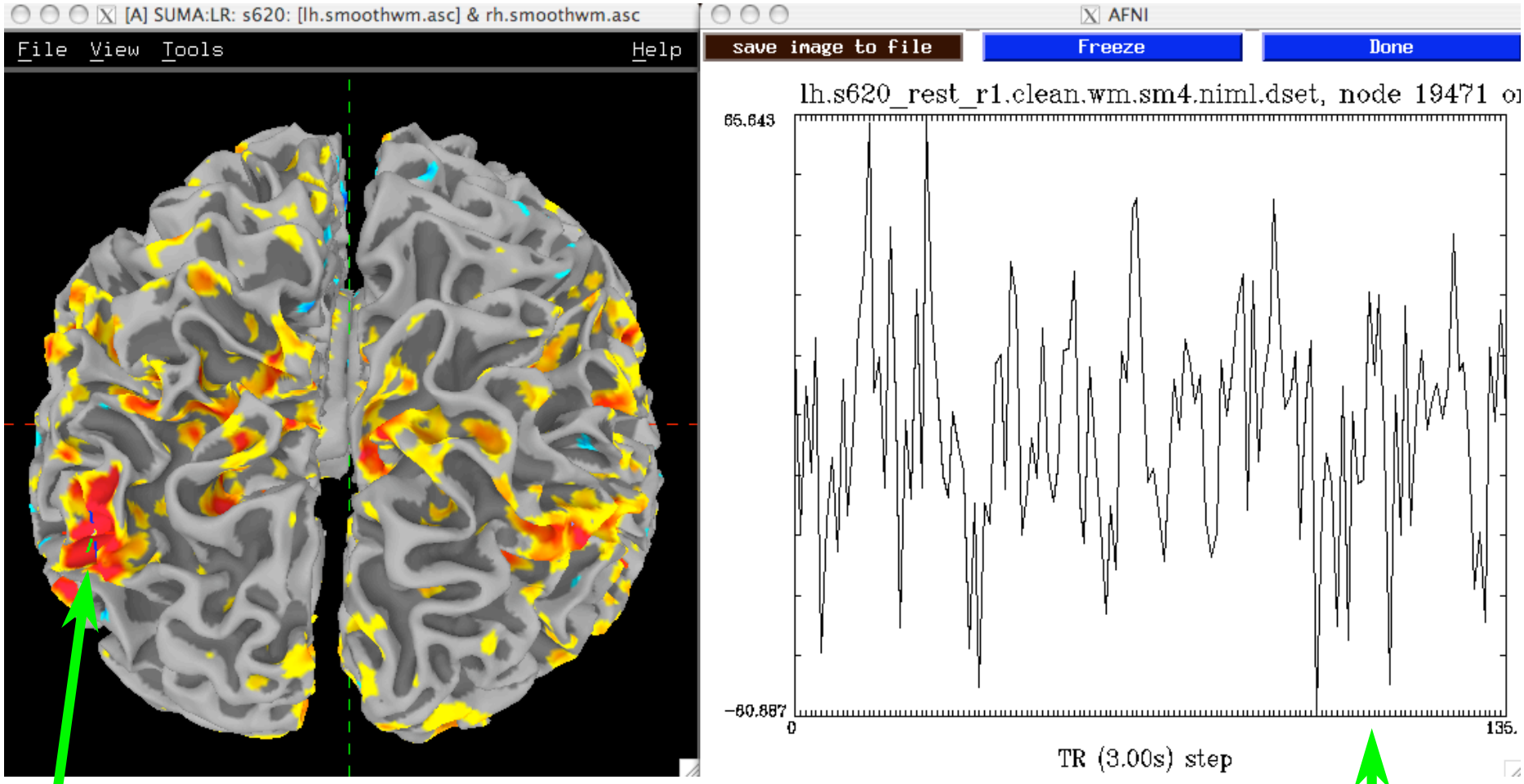


InstaCorr

- Similar in concept to AFNI **InstaCorr** but requires some external pre-processing of time series datasets
  - ★ Removal of baseline, projection to surface, blurring
- In the **AFNI_data5/** directory, run the script

  tcsh ./@run_REST_demo
  - ★ starts SUMA with 2 hemispheres
  - ★ loads pre-processed datasets into SUMA
  - ★ sets up SUMA's **InstaCorr**
- After all the setup is ready, right-clicking on the surface will do the **InstaCorr** calculations

SUMA! InstaCorr: Sample



- Seed voxel and Seed voxel time series graph